San Diego Regional Decarbonization Framework

SUMMARY FOR POLICY MAKERS

School of GLOBAL POLICY & STRATEGY

SDG POLICY INITIATIVE

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Introduction

The global scientific consensus is unequivocal: the world is experiencing a human-caused climate crisis and our window to meaningfully reduce greenhouse gas (GHG) emissions is closing.[i] Human activities have warmed the planet through rapid accumulations of GHGs in the atmosphere and the ocean, causing rapid and alarming changes. Global compacts, like the Paris Climate Agreement, and California policies from legislation and executive orders recognize the immediacy of decarbonization required across industries. Where past diplomatic efforts have failed to achieve enough progress on climate change, regional problem-solving models that account for both global commitments and local needs can represent a more effective approach.

The San Diego Regional Decarbonization Framework's (RDF's) Technical Report provides *technical and policy pathways to decarbonization in the medium-term to inform near-term policymaking* in regional, County, and city governments. The report models science-based pathways to net zero carbon emissions for the San Diego region by 2045, consistent with the Paris Climate Agreement and California State (State) mandates. The pathways provide a shared vision for the San Diego region to collectively reduce net GHG emissions in alignment with California's net zero goal. This report is a technical analysis of how different sectors in the energy system can contribute to decarbonization, but does not identify the "right" pathway. Instead, it shows numerous ways to achieve regional emissions goals in multiple sectors to highlight trade-offs, co-benefits, decision points, risks, and synergies. The analyses and pathways should be updated as technologies evolve or uncertainties are resolved or clarified. To that end, the report explores policy processes to help regional jurisdictions learn about uncertainties and adjust strategies as information arises.

Study Framework and Key Policy Considerations

This report considers how to achieve deep decarbonization of San Diego's regional energy system, which is defined as the total production and consumption of energy in the electric power, transportation, and buildings sectors, to align with State and national pathways to reach net zero. Deep decarbonization refers to the process of drastically reducing carbon dioxide (CO_2) and other GHG emissions throughout the economy. By "net zero," this report means that human-caused CO_2 emissions from the energy system equal human-caused CO_2

[i] Intergovernmental Panel on Climate Change (IPCC), "Climate Change 2022: Impacts, Adaptation, and Vulnerability. Summary for Policymakers." WGII Sixth Assessment Report, February 2022. Available at: https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_FullReport.pdf

removal and storage, thus making net energy system emissions zero.[i] The RDF's Technical Report does not rely on offsets outside the region to reach net zero targets. Importantly, emissions from other sectors such as waste were excluded from this analysis because they are outside the defined energy system scope, which accounts for 80% of regional emissions.[ii] Nevertheless, there are numerous co-benefits associated with drastically reducing emissions from other sectors and the emissions reductions and/or co-benefits may also align with State goals, as with reducing landfill emissions through waste diversion and composting.

The RDF's Technical Report's decarbonization pathways were modeled from larger national and State deep decarbonization scenarios to ensure alignment with Statewide pathways to decarbonization. Evolved Energy Research (EER) downscaled State and national models to develop regional models under five scenarios (also referred to as model cases).[iii] The deep decarbonization models allow for quantitative comparative analyses of regional policy options and decarbonization outcomes in different sectors. An example of EER's modeling outputs for the energy sector show how the different model cases affect Statewide decarbonization in both the total installed electricity capacity required (Figure 1) and CO_2 emissions from energy and industry processes through 2050 (Figure 2). Using these downscaled models is also important because local energy and transportation systems are interconnected with other regions and states, so regional jurisdictions should collaborate with other regional and state jurisdictions as they decarbonize.

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[i] Note that the energy system modeling only considers CO_2 emissions, whereas the natural climate solutions and Climate Action Plan analyses consider other greenhouse gases as well (such as methane, nitrous oxides, etc.). These GHGs are converted to their "carbon dioxide equivalent" (CO_2e) for easier comparison.

[ii] More details on the scope of the study are available in Chapter 1 and Appendix A. More details on the sectoral contributions to total regional emissions are available in Chapter 8 and in the San Diego Association of Government's 2021 Regional Plan's Appendix X (https://sdforward.com/docs/default-source/2021-regional-plan/appendix-x---2016-greenhouse-gas-emissions-inventory-and-projections-for-the-san-diego-region.pdf?sfvrsn=8444fd65_2).

[iii] More details on the model cases can be found in Chapter 1 and Appendix A.

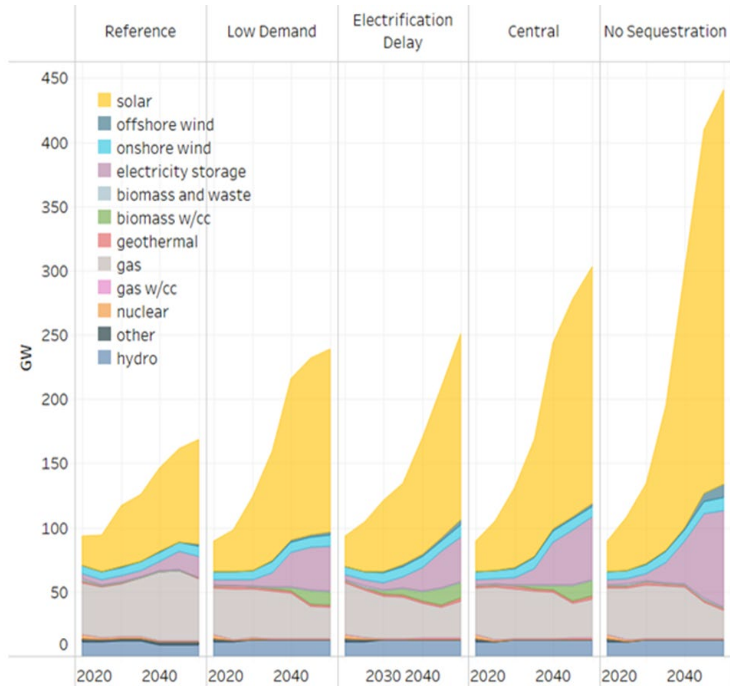

Figure 1. Results for the total installed electricity capacity required in California to reach net zero Statewide emissions by 2050 under five different model scenarios (or cases) in the EER model. Appendix A offers more information about the EER model, downscaling, and model scenarios.

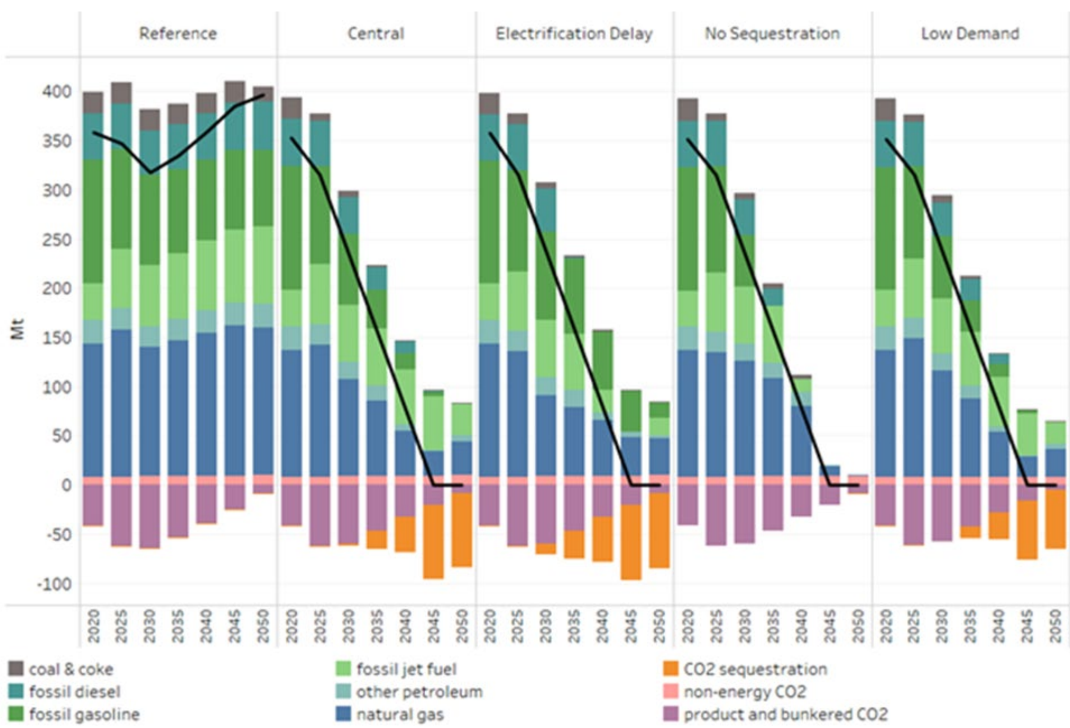

Figure 2. Results for CO_2 emissions from energy and industrial processes in California from the EER model for five different scenarios (or cases). Colors above the x-axis represent positive emissions, and colors below represent offsetting negative emissions. The black line indicates net CO_2 emissions. "Product and bunkered CO_2" is either CO_2 that ends up sequestered in materials (e.g., asphalt sequesters CO_2 during its production) or CO_2 reductions not counted in current inventories (e.g., interstate aviation emissions reductions are not included in a single state's emissions accounting, but intrastate aviation is).

Experts in renewable energy production, transportation, and buildings modeled technically feasible decarbonization pathways for the region to create a science-based roadmap of regional decarbonization to net zero emissions by mid-century. These models focused on proven, scalable technologies for decarbonizing the region's largest GHG emitters (Figure 3) that are within the jurisdiction of local governments and agencies. This excluded technologies in experimental or early phases because regional authorities cannot immediately deploy them at scale. Similarly, renewable energy development in State and federal waters were not included in modeling efforts except to contextualize resource availability in the San Diego region.

Additionally, the RDF's Technical Report highlights uncertainties in the decarbonization process and the need for ongoing planning processes that can adapt as the technology and policy landscapes evolve. For example, increased renewable energy availability from Imperial County or Mexico may affect the San Diego region's renewable energy mix, which could avoid the need to build higher-cost renewable energy infrastructure locally. Similarly, State and/or Federal development of offshore wind could reduce the need for onshore renewable infrastructure development in the San Diego region.

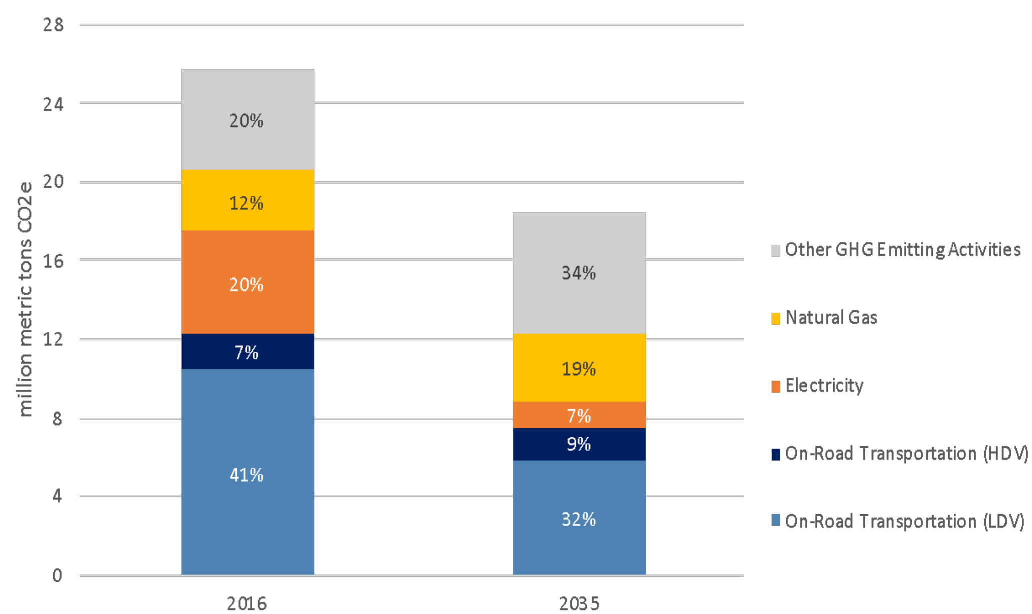

Figure 3. Region-wide estimates of the emissions of carbon dioxide equivalent (CO_2e) measured in million metric tons. The "other" category includes emissions from industrial sources, off-road transportation, waste, aviation, water, etc., which were not considered in the RDF's Technical Report. Note that 2035 values account for the impacts of certain State and federal actions. Source: the SANDAG 2021 Regional Plan's Appendix X, available here: https://sdforward.com/docs/default-source/2021-regional-plan/appendix-x---2016-greenhouse-gas-emissions-inventory-and-projections-for-the-san-diego-region.pdf?sfvrsn=8444fd65_2

Key Policy Considerations

The RDF's Technical Report identifies "low-regret" strategies which provide the best assessment of the least cost and most effective near-term solutions for reducing emissions in each sector. These strategies represent robust decarbonization actions in the near-term, regardless of how uncertain factors resolve, but whether they are the best pathways over the long term remains unknown (Table 1).

Successful decarbonization requires both technical solutions and policy strategies that can adapt with changes in scientific understanding and local political and economic conditions. Effective learning and policy adjustment requires that local actors – both leaders and people on the front line – first implement initial solutions and then engage in systematic and continuous review of results to drive meaningful learning about what works and what does not. The "best" solutions and pathways can and should evolve over time as science and technology advance and as local actors learn what is effective in the San Diego region.

Table 1 Examples of "Low Regret" Strategies in the Four Sectoral Pathways.

Renewable Energy Siting ● Support distributed solar resources (including rooftop solar and infill solar in areas like parking lots), particularly in low-income communities. ● Begin planning for utility-scale development in areas identified by most scenarios (e.g., the planned JVR region).	**Transportation** ● Encourage denser and mixed-use development around existing and new trolley stops, transit corridors, and mobility hubs. ● Electrify fleet vehicles (jurisdictions, agencies, school districts, etc.). ● Require electric vehicle (EV) hookups in new construction or additions; streamline building permits for EV retrofits.
Buildings ● Create incentives for replacing end-of-life space and water heaters with electric alternatives. ● Make new buildings "all-electric." ● Focus on electrifying low-income, disadvantaged, and rental residences.	**Land Use and Natural Climate Solutions** ● Protect natural and working lands. ● Bolster carbon farming throughout the region. ● Increase tree, shrub, and plant cover in urban and suburban areas.

The RDF's Technical Report proposes region-wide institutional governance to facilitate continued collaboration and learning across jurisdictions.[i] Organized into a Regional Steering Committee, Sector Working Groups, and Front-Line Advisors, this structure would unite government officials, planning bodies, regulators, industry stakeholders, experts, and front-line

[i] More information on collaboration and learning across jurisdictions is available in Chapter 7.

workers in each sector from across the region to test, evaluate, and adjust strategies. Such a structure is necessary because achieving the significant changes and rapid learning needed to address climate change is a collective action problem. Individually, local jurisdictions and agencies in the San Diego region have limited authority over the suite of actions needed to decarbonize. Region-wide cooperation can increase collective impact through clear, credible, and consistent policy signals, joint problem-solving, pooling of experience about what works, and greater leverage and capacity from combined resources. As discussed in Chapters 7 and 8, examples of regional cooperation include setting incentives for action, collecting data, conducting analyses, supporting policy development and implementation, convening stakeholder and working groups, and monitoring progress. A Regional Climate Action Joint Power Agreement (JPA) or other formal mechanism could facilitate such cooperation, thereby scaling strategic thinking and decision-making around decarbonization. Figure 4 outlines an institutional process through which regional governance, informed by the technical solutions proposed in the RDF and ongoing stakeholder engagement, can drive meaningful learning in each sector.

Within this institutional process, the RDF's Technical Report also proposes two strategies for engaging with actors and agencies beyond the San Diego region to maximize impact within the region. First, regional decarbonization leaders must engage continually with outside agencies, especially at the State level, to influence policies that affect local efforts (e.g., renewable energy regulations). Second, local leaders should leverage the region's technology-focused private sector and multiple universities to establish the San Diego region as a test bed for pilot and demonstration projects. While regional-scale investments in innovation alone are unlikely to dramatically impact technological readiness across all sectors, local testing and deployment of technologies developed elsewhere can contribute to the global effort to push the frontier of science on climate solutions. External engagement not only supports local emission reductions, but also promises to bring outside resources and attention from State and federal policymakers, with potential positive effects on the local economy.

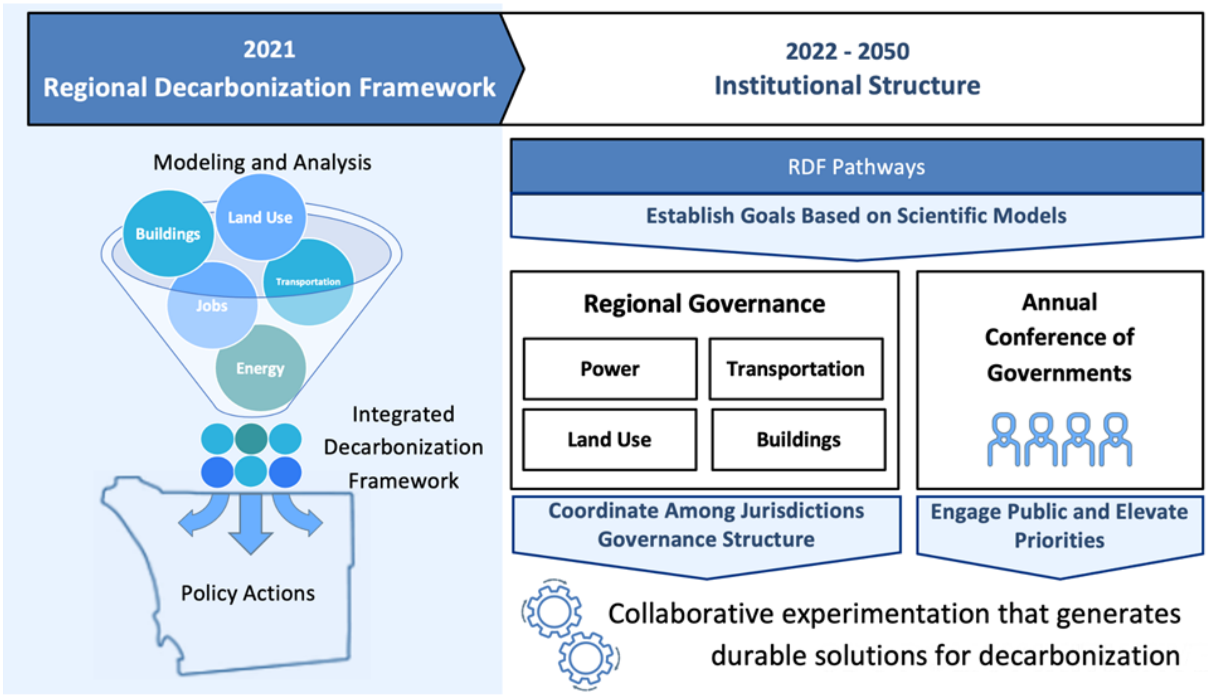

Figure 4. The RDF's Technical Report as part of an Integrated Decarbonization Framework and institutional structure. This structure could include San Diego's regional governance bodies and a conference of governments, for example.

In sum, the RDF proposes institutionalizing a highly transparent, cooperative process for eliciting new information about "what works" with deep decarbonization, comparing best practices within the region, and engaging outside the region with policymakers, industry stakeholders, and other experts contributing to the evolution of national strategies. These not only maximize local emissions reductions, but also enable the San Diego region to influence State and federal climate policy and become an effective leader for other jurisdictions. The San Diego region makes up just 0.08% of global emissions, so generating followership represents the region's best route to truly make an impact on mitigating climate change.

Decarbonizing Electricity

The RDF's Technical Report identifies low-environmental-impact, high-quality, and technically feasible areas for renewable energy infrastructure development in the San Diego region and neighboring Imperial County. Electricity emissions accounted for approximately 20% of the 2016 Regional Greenhouse Gas Emissions Inventory for the San Diego region and comprise the second largest emissions source in the region (Figure 3). Decarbonizing electricity production will require substantial deployment of new renewable resources. Siting renewable energy infrastructure and facilities can have significant impacts on the environment and will require new and upgraded transmission infrastructure. Thus, the RDF includes a series of scenarios with different land footprints that are meant to inform the political discussions in jurisdictions across the region on the trade-offs regarding land use and renewable energy costs.

The San Diego region has sufficient available land area for wind and solar generation to approach a fully decarbonized energy system in line with the California-wide system model. However, meeting standards for reliability will require significant, but uncertain, investments in a suite of additional resources, including excess intermittent and flexible generation, storage, and demand-side management. The region can produce the projected 2050 energy demand of 49,979 gigawatt hours (GWh) per year with local utility-scale onshore wind and solar development (Table 2). However, demand for energy may be higher or lower than the renewable energy supply at a given time (for example at night or on cloudy days), necessitating investments in additional energy storage infrastructure to supply reliable renewable energy to the region. However, the costs of these additional resources, such as batteries and pumped storage hydropower, remain highly uncertain.

Levelized Cost of Energy (LCOE), which is the adjusted cost of electricity production per megawatt hour (MWh) that includes transmission costs, was used as a metric to compare project costs. LCOE allows for both direct comparison of projects and flexibility as uncertainties are resolved and as infrastructure (power plants, transmission lines, interconnections, etc.) is built. LCOE can estimate the wholesale cost of electricity for utility-scale projects. LCOE includes costs of initially building the wind or solar plant and the cost of interconnecting that project to the grid, which are divided by total energy production to get a cost per unit of energy output. Transmission costs are included in the project capital costs and are based off the California Independent Systems Operator (CAISO) Transmission Planning Process documents. LCOE is a way to compare different types of energy projects based on a per unit of energy produced. For example, LCOE metrics make it possible to compare a solar power plant to a natural gas power plant based on cost per MWh that it can produce.

Table 2. Candidate project areas (CPAs) and total annual resource potential in San Diego County and Imperial County. Utility-scale resources refer to large scale projects for solar, wind, and geothermal resources. Other resources are from smaller scale projects, including rooftop solar, infill solar or wind, and brownfield solar or wind. Geothermal CPAs are discrete areas and are listed as the number of potential sites rather than by their total area. Total annual demand for the San Diego region by 2050 is estimated as 49,979 GWh.

	San Diego County		San Diego County + Imperial County	
Findings	Utility-Scale Only	With Rooftop, Infill, and Brownfield	Utility-Scale Only	With Rooftop, Infill, and Brownfield
Solar				
Area (sq km)	661	985	3,417	3,741
Potential (GWh)	54,784	102,925	84,888	109,742
Onshore Wind				
Area (sq km)	86	86	3,712	3,749
Potential (GWh)	730	730	22,540	22,572
Offshore Wind				
Area (sq km)	1,660	1,660	1,660	1,660
Potential (GWh)	9,869	9,869	9,869	9,869
Geothermal				
Number of sites	0	0	5	5
Potential (GWh)	0	0	10,680	10,680
Total Renewable Resource Potential (GWh)	65,382	113,523	117,296	142,183
Electricity Resource Balance (GWh)	15,403	63,544	67,317	92,204

The RDF's Technical Report creates multiple site-selection scenarios for renewable energy infrastructure to inform decision-making. These include least-cost scenarios; scenarios that include Imperial County solar, wind, and geothermal resources; scenarios that minimize impacts to different land types; and scenarios with different mixes of wind and solar resources (both distributed and utility-scale) in urban, greenfield, and brownfield sites. The least-cost scenarios (Scenarios 1 and 2) selected utility-scale renewable energy sites from lowest to highest LCOE. Additional scenarios prioritize different policy goals such as avoiding certain lands (Scenarios 3 – 5) or prioritizing development on certain lands (Scenarios 6 and 7). Other scenarios combine resources and policy priorities (Scenarios 8 and 9). The scenarios are as follows (see Table 3 for values):[i]

1. Least-cost, high local capacity (San Diego county only) (Figure 5);
2. Least-cost, high transmission deliverability (San Diego and Imperial counties) (Figure 6);
3. Minimize Loss of Land with High Conservation Value (Figure 7);
4. Minimize Loss of Land with High Monetary Value;
5. Minimize Loss of Land with High Carbon Sequestration Potential;
6. Utilize only Developable Land;

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[i] See sections 2.4.5 and 2.4.6 for descriptions of the data and methods for site and candidate project area selection. See sections 2.5.1 and 2.5.2 for scenario results, discussion, and maps.

7. Infill and Rooftop Solar Scenario;
8. Mixed Mode Scenario (includes a combination of developable areas in the region and nearby areas with transmission upgrades, nearby geothermal, rooftop solar, brownfield solar and wind, and battery storage) (Figure 8); and
9. Maximize Rooftop Solar, Minimize Impact to Conservation and Agricultural Lands.

Table 3 Scenario summary of renewable energy resource potential and energy deficit with predicted demand. All values are in GWh. The "deficit with demand" values are based on the EER model's Central Case annual demand estimates of 49,979 GWh for the San Diego region by 2050.

Scenario number	*Scenario Description*	*Resource Type*	*Resource Potential (GWh)*	*Excess (Deficit) with Demand (GWh)*
Scenario 1	Least-cost (San Diego county only)	Solar, Wind	49,979	–
Scenario 2	Least-cost (San Diego and Imperial counties)	Solar, Wind, Geothermal	49,979	–
Scenario 3	Low Environmental Impact	Solar, Wind	15,777	(34,202)
Scenario 4	Low Land Value	Solar, Wind	52,394	2,415
Scenario 5	Carbon Sequestration Potential	Solar, Wind	22,844	(27,135)
Scenario 6	Developable	Solar, Wind	13,894	(36,085)
Scenario 7	Rooftop and infill solar	Solar	17,478	(32,501)
Scenario 8	Mixed-mode resource mix (San Diego and Imperial counties)	Solar, Wind, Geothermal	50,147	168
Scenario 9	High Rooftop, Low-Impact to Conservation Lands, Avoid Valuable Agriculture Lands (San Diego and Imperial counties)	Solar, Wind	44,177	(5,802)

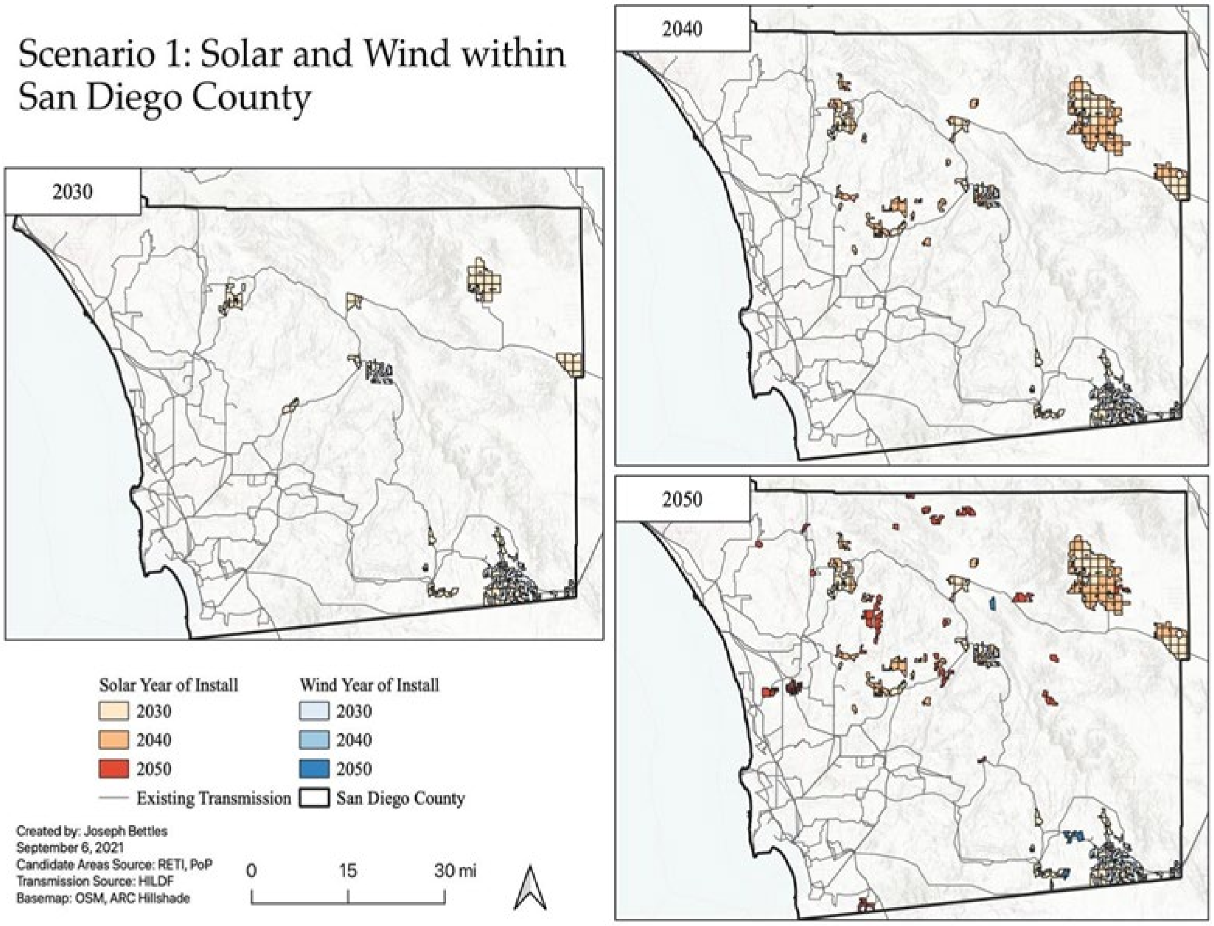

Figure 5. Scenario 1: Least-cost scenario in the San Diego region only. This analysis selects utility-scale solar and onshore wind resources from lowest to highest cost to meet projected energy demand. The three panels show the build-out required by each year that would allow the region to approach full energy decarbonization by 2050. Lighter colors represent Candidate Project Areas (CPAs) that would be built earlier because they are less expensive. Blue colors are wind resources and orange/red colors are solar resources. This scenario has an average levelized cost of energy (LCOE) of $40.65 per megawatt hour (MWh).

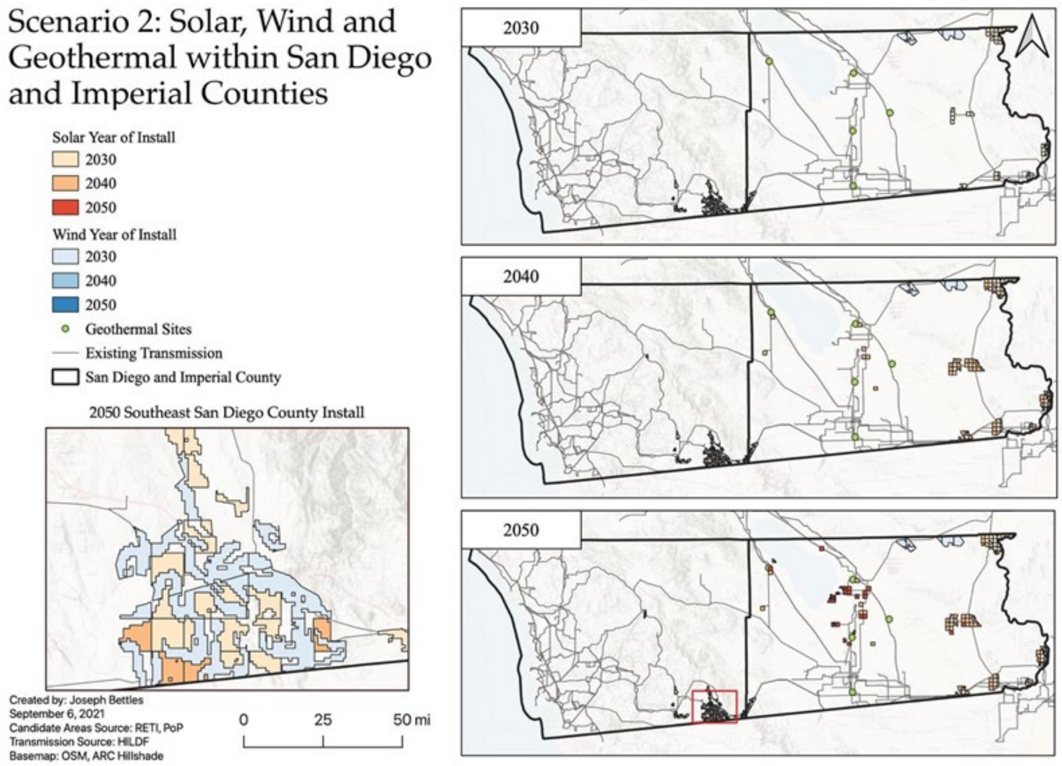

Figure 6. Scenario 2: Least-cost scenario in San Diego and Imperial counties. This analysis selects solar, onshore wind, and geothermal resources from lowest to highest cost to meet projected energy demand. These maps show build out over three time periods where colors represent build out year (lighter colors are earlier) and resources (red/orange for solar, blue for wind, and green for geothermal). The inset shows the Jacumba Hot Springs area site selection by 2050 and the area that includes the proposed/planned Jacumba Valley Ranch (JVR) sites. This scenario has an average LCOE of $42.04 per MWh.

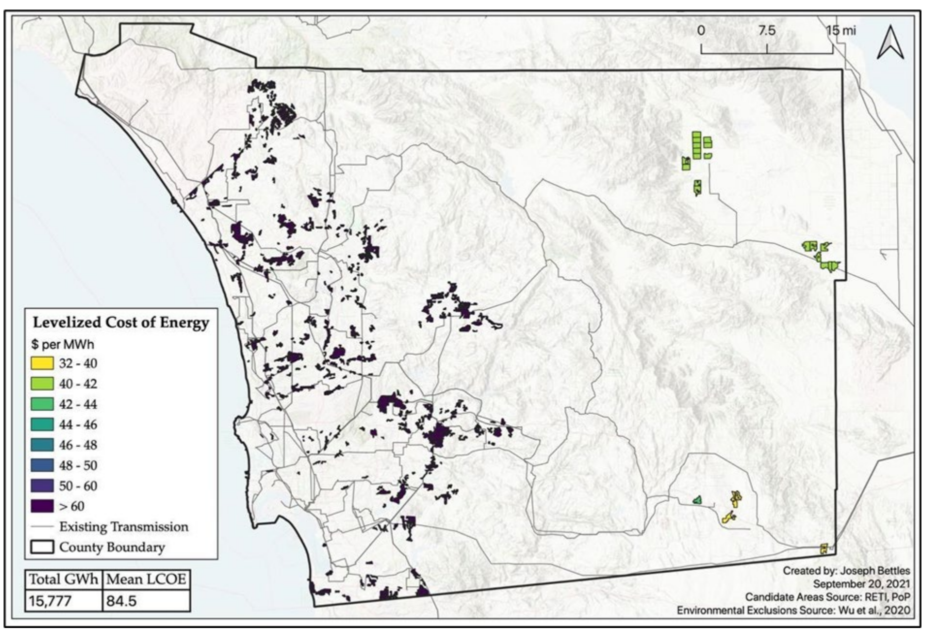

Figure 7. Scenario 3: Exclude land with high conservation value. This scenario minimizes impacts to areas of high conservation value and other areas that are environmentally sensitive or important. It does not meet regional energy demand and is relatively more expensive (with an average LCOE of $84.5 per MWh).

The mixed-mode scenario utilizes a mix of proven, scalable technologies that are within the jurisdictions of San Diego county, Imperial county, or regional entities to build in order to meet regional demand both in the near-term (2025) and by mid-century (shown in Figure 8). The technologies include brownfield infrastructure development (solar and wind infrastructure built on currently or formerly contaminated sites); utility-scale solar and wind in both San Diego and Imperial counties; rooftop and infill solar (where "infill solar" is defined as solar projects built in dense, urban settings); and geothermal (which is a clean source of baseload power that does not rely on wind, sun, or other variable energy sources).

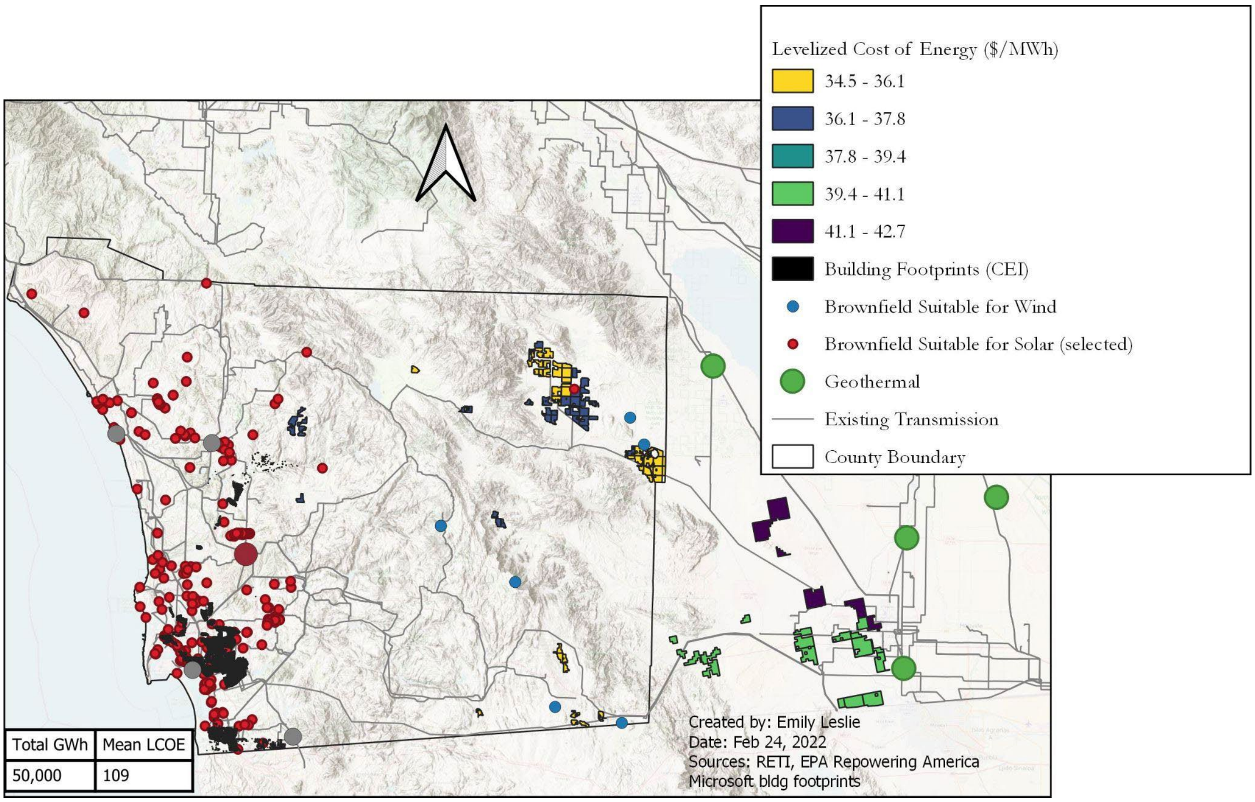

Figure 8. Scenario 8: Mixed-mode Scenario 2050. This figure shows sites selected to meet the 2050 electricity demand using a variety of resources: 12% rooftop solar, 23% brownfield solar, 0.1% brownfield wind, 6% utility scale solar on developable land in San Diego county, 0.4% utility-scale wind on developable land in San Diego county, 38% Imperial solar, 21% Imperial geothermal. The addition of rooftop solar and brownfield resources together results in 35% reduction in land area impacts. This meets regional energy demand, but it has a high average cost (with an average LCOE of $109/MWh) partly because of the high costs of rooftop and brownfield development, as well as the high cost of geothermal.

There are some commonalities across scenarios in the results, suggesting that these might be "low-regret" renewable energy infrastructure options. The geospatial analyses of renewable energy siting have demonstrated that rooftop solar, infill solar, and brownfield development reduce overall land use change in natural and working lands. Additionally, these resources can bring co-benefits to communities, such as pollution reduction and economic opportunities. Thus, despite the relatively high costs compared to utility-scale development, building distributed and urban renewable resources are low-regret strategies that have low impacts on habitats, agriculture, and rural communities and can provide attractive job training opportunities where few such opportunities currently exist relative to utility-scale development.[i]

Given the high commercial interest and relative proximity to planned or existing renewable sites, the models highlighted the Jacumba Valley Ranch (JVR) renewable area in most scenarios. State planning proceedings favor this area, including those by the CAISO (California's grid operator) and the California Public Utilities Commission (CPUC), and it may represent a low-regret scenario for utility-scale infrastructure expansion. These scenarios are not prescriptive and any policy decision will require careful consideration of environmental justice and a deeper understanding of the effects that these energy developments will have on communities of concern, low-income communities, rural communities, and/or disadvantaged communities.

Imperial County has significant solar and geothermal resources that could provide energy to the San Diego region, but this may require upgrades to the transmission network. As renewable energy infrastructure develops in neighboring areas – such as Imperial County, Mexico, or offshore – the site selection scenarios will change in iterative energy supply and demand analyses. Similarly, as new technologies and permitting make additional renewable energy resources available (e.g., offshore wind, wave energy, etc.), the scenarios must update to account for the energy supply from those novel resources (see Table 3 for geothermal and offshore wind values). This framework is flexible enough to account for additional renewable energy supply as it becomes available.

The region should coordinate with State agencies to ensure the reliability of the system. The San Diego region is a part of a larger energy system network, so coordination across agencies must underpin decision-making, planning, and implementation of renewable energy infrastructure into the future. For example, there are State-level Integrated Resource Plan (IRP) proceeding at the CPUC. Load Serving Entities (LSEs) throughout the State are Parties to this proceeding, and local LSEs, such as San Diego Gas and Electric (SDG&E) and Community Choice Aggregators (CCAs), are required to submit annual procurement plans. These submittals help the State anticipate potential reliability issues and help the CAISO plan transmission upgrades needed to accommodate the LSE plans and climate goals. LSE submissions to the CPUC should indicate their expected local distributed generation, rooftop solar, community solar, equity-eligible contractor projects, or other specifications. Additionally, regional government officials often serve on CCA boards and participate in procurement, planning, and target setting. Board

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[i] See the complementary workforce development report by Inclusive Economics, Inc. for a larger discussion on the job quality and access characteristics of utility-scale renewable energy versus distributed energy. The report, titled "Putting San Diego County on the High Road: Climate Workforce Recommendations for 2030 and 2050," is available on the County's website: https://www.sandiegocounty.gov/content/dam/sdc/lueg/regional-decarb-frameworkfiles/Putting%20San%20Diego%20County%20on%20the%20High%20Road_June%202022.pdf.

members can help ensure that LSE plans are implemented for consistency with regional and State GHG reduction targets. This is especially important where local targets are more ambitious than State targets.

Beyond the IRP, there are additional State agency proceedings which could benefit from input from local players (e.g., the CPUC Resource Adequacy proceeding, CAISO Transmission Planning Process, and the CAISO Local Capacity Requirements proceeding). In the Resource Adequacy proceeding, CPUC staff analyze power grid reliability. In the Transmission Planning Process, the CAISO assesses reliability, policy compliance, and cost-effectiveness of planned transmission system upgrades. In the Local Capacity Requirements proceeding, the CAISO conducts a more local reliability analysis than other proceedings. For example, Section 3.3.10 of the CAISO 2022 Local Capacity Technical Study is devoted to the San Diego-Imperial Valley region. LSEs such as SDG&E, San Diego Community Power, and Clean Energy Alliance should coordinate on procurement, resource adequacy and other issues addressed in these proceedings.

Numerous State goals affect electricity decarbonization, including requirements for rooftop solar on certain new buildings, requirements for a fully decarbonized electricity system by 2045, and allowances for additional decarbonization efforts beyond State goals. Electricity decarbonization is the most common CAP measure analyzed and on average contributes more GHG reductions than any other measure. Most CAPs include a measure to form or join a CCA program, and additional jurisdictions can increase CCA participation or commit to 100% carbon-free energy prior to the State 2045 deadline. Additionally, local efforts can enhance or complement State rooftop solar requirements by adopting reach codes (regulations that go beyond State requirements) and evaluating mandates or incentives for energy storage systems paired with rooftop solar to decrease marginal emissions during the electric system's peak GHG emission and increase reliability.

Additional work would be needed to make carbon-free electricity supply more accessible. Historically, rooftop solar has been installed in higher-income neighborhoods and in areas with higher levels of homeownership. Numerous levers could address the inequitable distribution of rooftop solar installations, including targeted incentives and financing. Additionally, CCA programs can maximize participation in the Disadvantaged Communities Green Tariff Program, subsidize customers in income-qualified discount programs to opt-up to 100% carbon-free electricity service options, and support inclusive financing for energy upgrades.

Legal authority to regulate energy production:[i] Jurisdictions in the San Diego region have the authority to require levels of carbon-free electricity supply through CAPs and procure carbon-

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[i] See Chapter 8, section 8.7 "Decarbonize the Electricity Supply" and Appendix B for further discussion of legal authority.

free electricity supplies through CCAs and can therefore supply more carbon-free energy than required by State agencies. However, State and/or federal agencies or entities still regulate local energy supplies for reliability, which complicates fully decarbonizing the electricity supply with renewable energy. Additionally, local jurisdictions are also authorized to support alternatively fueled thermal power plants and related infrastructure that can provide low- or zero-emission electricity to meet reliability and air quality requirements (e.g., green hydrogen production and/or power plants). Local jurisdictions are also authorized to streamline permitting and increase distributed generation through CCAs and reach codes. Further regulating most fossil-fueled thermal power plants emissions is limited given current State regulation and uncertainty over federal preemption.

Decarbonizing Transportation

The transportation sector is the largest contributor to regional GHG emissions. In 2016, on-road transportation was responsible for almost half of regional emissions. In 2035, emissions from on-road transportation are projected to account for about 41% of the total projected emissions (Figure 3).[i] Statewide legislation, executive orders, and State agency targets have set GHG reduction goals to address these emissions. Additionally, the San Diego region has implemented measures to reduce regional transportation GHG emissions, including a variety of vehicle miles traveled (VMT) reduction and vehicle electrification strategies.

The region has a strong policy foundation for reducing emissions related to transportation. However, current commitments through CAPs and other policies are inconsistent with the scale of reductions required by State executive orders for carbon neutrality. Even the best CAP commitments to reduce on-road transportation emissions through VMT reduction, EV adoption, and fuel efficiency strategies, if applied to the whole region, are not projected to achieve the State's zero emissions goals.

Opportunities to accelerate EV adoption and VMT reduction exist based on current regional policies and patterns of vehicle ownership, travel behavior, and land use development. Current policies and consumer, driver, and developer behaviors are already increasing EV adoption and reducing VMT. However, there are additional opportunities to accelerate regional transportation decarbonization. To **reduce VMT**, jurisdictions can focus on high-density development around transit corridors, rail, and trolley stations, and enhance transit and active transportation (e.g., biking and walking). Adopting "smart growth" policies improves urban and suburban connectivity, encourages mixed-use developments, shortens trip lengths by changing

[i] See Chapter 8, section 8.5 for a detailed analysis of CAP commitments as they relate to transportation. Note that this value includes projected EV sales changes but does not include CAP measures.

zoning, and disincentivizes free parking.[i] To further **reduce emissions**, jurisdictions can establish and enforce existing anti-idling requirements (especially around schools), identify areas for traffic calming measures, and provide driver behavior incentives. Further, local jurisdictions can affect vehicle retirement, which can be prioritized in communities of concern to rapidly reduce local air pollution burdens. Finally, local governments can **increase adoption of zero-emission vehicles (ZEVs) through provision of public EV charging stations and** use of alternative, low-carbon fuels and EVs, particularly for medium-and heavy-duty vehicles, in existing and future fleets. Figure 9 shows a menu of policy opportunities to increase ZEV adoption, illustrating policy options that range in both effectiveness (i.e., how well the policy increases ZEV adoption) and breadth (i.e., how many people it reaches).

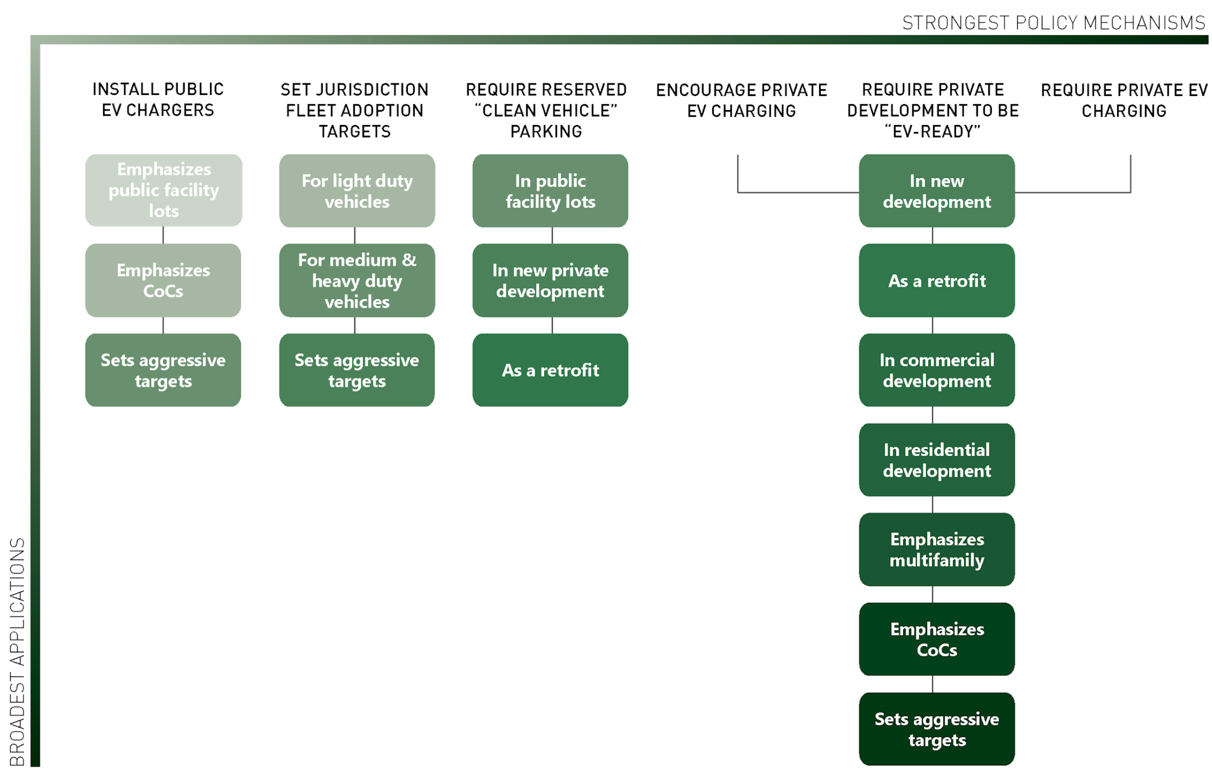

Figure 9. A spectrum of policy options to accelerate ZEV adoption. Policies are likely to be more effective moving right and are likely to have a broader application moving down. Thus, the bottom right is predicted to be the most effective and to have the broadest application of the policy measure shown where the top left is predicted to be the least effective and to have the narrowest application of the policy measures shown.

Multiple opportunities for regional collaboration and coordination exist. The nature of on-road transportation and of existing institutions that coordinate transportation decisions suggest that regional collaboration on transportation decarbonization will be more effective than individual CAP measures. CCAs provide an example of a local mechanism, usually through JPAs,

[i] Opportunities to increase density in in-fill areas have been identified in Chapter 3. Chapter 8 offers more details on how to reduce VMT.

that can support transportation electrification by developing programs to locally incentivize EV uptake beyond State and federal programs. Similarly, other regional collaboration efforts may be identified which can promote local funds for transportation decarbonization. Local jurisdictions can further collaborate to assess the equitability and effectiveness of investing in EV deployment versus increased mass transit in various communities and align regional transportation equity analyses (e.g., SANDAG's equity analyses) with CAP equity analyses (e.g., the City of San Diego's equity analyses).

Legal authority to regulate transportation decarbonization:[i] Local jurisdictions and agencies in the San Diego region have broad authority over transportation, based both on locally derived land use authority over planning and development and based on delegated State and federal authority. However, such delegated authorities can be limited or preempted by State or federal laws, as with fuel and tailpipe emission regulations. Through their authorities, local jurisdictions can establish climate change policies and regulations to reduce GHGs from transportation in general plans (GPs), CAPs, zoning, or transit-oriented development regulations. Further, they can require infrastructure for fuel switching in buildings (e.g., EV charging equipment), build supporting infrastructure in public right-of-ways or on public land, and support alternative fuel production and infrastructure, such as hydrogen. Local jurisdictions can regulate their own fleets through purchasing, maintaining, or changing their fleets. They also have the authority to regulate indirect transportation emissions to keep local emissions in line with federal and State air quality standards. State statutes and regulations create an opportunity to align local action that decreases implementation costs by bringing State funded projects to the region, particularly in communities of concern, and deploying technology developed by State or federal funding. Finally, jurisdictions appear to have additional legal authority through land use, transportation infrastructure siting, delegated authority, and taxation powers to reduce transportation GHGs than represented by commitments in CAPs. Assessing the limits of local authority to increase on-road transportation GHG reductions requires additional work.

[i] See Chapter 8, section 8.5 "Decarbonize Transportation" and Appendix B for further discussion of legal authority.

Decarbonizing Buildings

The RDF's Technical Report studies the building mix and associated emissions from the region's infrastructure and building sector. Direct emissions from buildings come from on-site fossil fuel combustion and contribute to regional GHG emissions (Figure 3). This analysis focuses on electrifying systems responsible for end-use emissions, like space and water heating, and using lower-carbon fuels (such as biomethane and hydrogen) where electrification is not yet feasible. The chapter considers three modeled pathways to reach a carbon-free building sector by 2050: a pathway emphasizing high electrification of fossil-fuel systems, a pathway with highly efficient electric heat pumps, and a pathway using low-carbon fuels to reduce emissions in the interim while electrification occurs more slowly.[i]

There are several near-term, low-regret actions for building decarbonization. First, replacing end-of-life fossil fuel heating systems with electric versions is a near-term priority, as some existing fossil fuel systems will only turn over once by 2050. Second, setting "electrification-ready" or "all-electric" standards for new construction and major renovations through building energy codes will reduce costs associated with transitioning away from fossil fuels. Third, improved data gathering represents a low-cost, foundational action for future policy development. More data on building emissions and decarbonization will better inform decision makers crafting policies for the building sector's contributions to a net zero region.

Replacing fossil fuel-based space heating and water heating systems with electric systems should be a primary policy focus for building emission reductions. Space heating and water heating together consume the vast majority of the natural gas supplied to residential buildings in the SDG&E service area (Figure 10). Commercial buildings are more varied in their energy consumption (Figure 11), but space and water heating still consume a large portion of total energy, and around two-thirds of commercial buildings space heaters use natural gas. Replacing space and water heating systems and other fossil fuel-based systems like ovens and dryers with electric versions will yield significant building decarbonization. Current heat pump technologies for space and water heating are readily available and outperform natural gas systems by providing more heating per unit of energy used, making these systems especially conducive to electrification. For building temperature regulation, electric heat pumps offer both heating and cooling from the same unit, making them ideal for homes that do not yet have air conditioning. Thus, regional policies should support adoption of efficient heat pump-based space and water heating systems to replace fossil fuel-based systems in both new and existing buildings.

Additionally, policies aimed at replacing fossil-fuel based space and water heating systems should focus assistance efforts on increasing uptake among low-income residents and rental

[i] More details on the modeled pathways are available in Chapter 4, section 4.4 and elsewhere in the chapter.

building owners. Such policies would address historic inequities in housing quality, environmental injustice, health disparities due to indoor air pollution, and utility costs. Further, they would ensure that building decarbonization includes low-income residents and renters, rather than leaving them to pay increasingly higher gas rates.

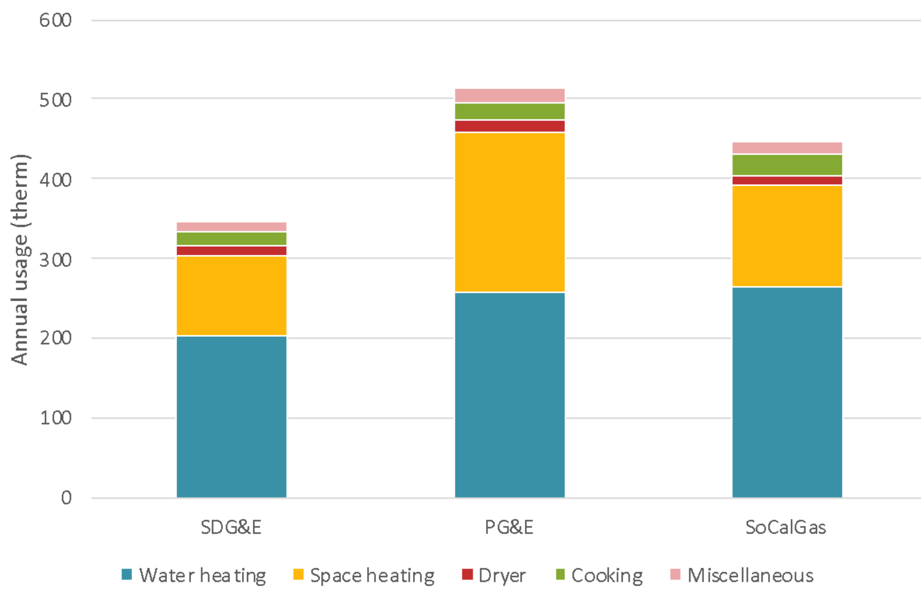

Figure 10. Average annual natural gas usage (measured in therms) by end use and by utility for households who use gas as the primary fuel for major end uses. Source: DNV GL Energy Insights (2021). 2019 California Residential Appliance Saturation Study (RASS).

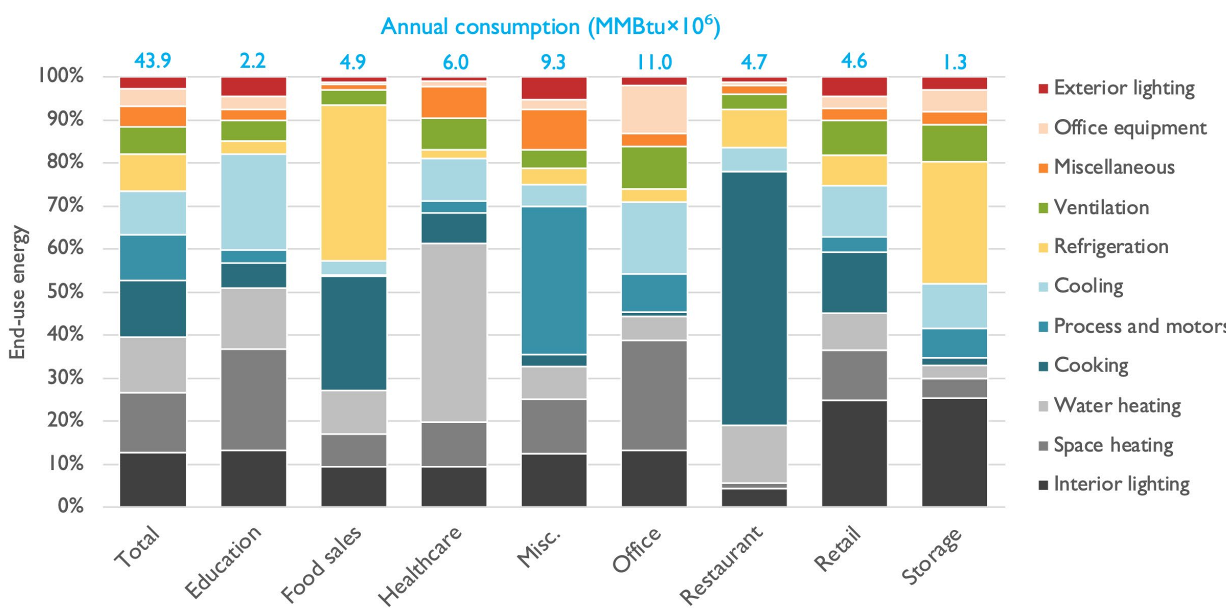

Figure 11. San Diego regional energy end-use profiles by commercial building type. Percentages are relative to total end-use energy within each building sector. Annual energy consumption, measured in metric million British thermal units (MMBTU), for each building type is shown in blue at the top of the figure. Water heating is in light gray (third from the bottom in each bar) and space heating is in medium gray (second from the bottom in each bar). Natural gas consumption per system varies by commercial building type, but space and water heating are still significant natural gas consumers, as is visible in the leftmost column ("Total"). Source: Synapse model.

Policies for decarbonizing existing and new buildings are crucial. 80% of the buildings that will exist in 2050 have already been built, so decarbonizing the building sector requires decarbonizing the current building stock. While State building codes, like Title 24, regulate building alterations and additions to certain existing structures, local policies could further encourage or require energy efficiency and electrification in many other places.[i] For instance, decarbonizing municipal buildings through cost-effective electrification should reduce operation costs and may encourage property owners to follow suit, making it a low-regret policy.

To decarbonize new buildings, jurisdictions can set local "electrification-ready" or "all-electric" standards for new construction. Policymakers can benefit from lessons learned in the adoption of all-electric reach codes or ordinances—which are local codes or ordinances that go beyond state or federal requirements codes or ordinances—in the cities of Carlsbad, Encinitas, and Solana Beach.

Low-carbon gaseous fuels can be used for hard-to-electrify end uses, though research and piloting are required. Some building systems are hard to fully electrify, so one way to reduce GHG emissions from those systems is to use fuels that do not emit net GHGs into the atmosphere.[ii] Similarly, such fuels can be used for these or other systems prior to electrifying them. Low-carbon gaseous fuels could include biomethane and/or hydrogen. However, each of these alternate fuels have cost and efficiency trade-offs as well as uncertainties, requiring more research and piloting before implementation.

Minimizing unnecessary extensions or replacements of the gas pipeline system and accelerating depreciation of existing utility assets mitigates the gas utility's risk of not recovering its investment in assets (i.e., its stranded cost risk). Phasing out end-use natural gas consumption in buildings can lead to stranded assets, defined as infrastructure that is shut down before the end of its useful life. For companies like SDG&E, stranded assets represent potential financial losses because of the high capital costs to build or replace gas infrastructure. Mitigating these stranded assets will be an important policy consideration.[iii] One step is to minimize unnecessary pipeline extensions or replacements. Policies requiring full electrification in new construction would mitigate stranded asset losses for pipe investments going to new

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[i] See Chapter 8, section 8.6, for more details on examples of local authorities decarbonizing existing buildings. Also see Chapter 7 section 7.3.1 for a local example.

[ii] One such example are district energy plants that provide high-temperature steam or hot water to geographic clusters of buildings. There are several such systems in the San Diego region that serve military bases, hospitals, or universities. System operators should evaluate the relative costs and benefits of low-carbon fuels and electric heating technologies (such as high-capacity heat pumps, heat recovery chillers, and electric boilers).

[iii] At the time of this writing, the Public Utility Commission is evaluating key aspects of long-term natural gas planning in California under proceeding R2001007.

customers, but not from replacing aging infrastructure. Exploring and piloting non-pipeline alternatives to both new and replacement infrastructure, including electrifying end uses instead of replacing infrastructure, could identify opportunities to mitigate risk.

CAPs have relatively few measures to electrify buildings and the GHG impact of those measures is relatively low, despite the sector's importance to regional decarbonization. Only seven CAPs in the San Diego region include measures related to building electrification and the GHG reductions in CAPs associated with efficiency and electrification are relatively low.[i] Compared to the level of electrification needed in both new and existing buildings as outlined in Chapter 4, the CAP measures fall short of the building decarbonization pathway findings in the RDF's Technical Report.

There is an opportunity and a need to assess social equity considerations of building decarbonization policies. Replacing appliances is expensive, so building decarbonization policies should account for incentivizing electrification equitably, especially in communities of concern, low-income communities, rural areas, and for renters. Developing the capacity and tools to understand and address the equity implications of building decarbonization policies in the San Diego region requires additional work.

Legal authority to regulate building decarbonization:[ii] Local jurisdictions have the authority to regulate GHG emissions from building end-use of fossil fuels and other energy sources, which represents the primary means of decarbonizing buildings. Local jurisdictions also act with delegated authority over the built environment to require more stringent energy codes, directly regulate air pollution emissions from buildings, and procure alternate energy supplies in public buildings. Additional authority may come from the California Environmental Quality Act (CEQA) by setting more stringent thresholds to determine environmental impact. Local governments are preempted from establishing energy efficiency appliance standards, regulating natural gas supply, transmission, and storage, and high global warming potential refrigerants (e.g., HFCs).

[i] See Chapter 8, Figure 8.33 for details on CAP commitments relating to building electrification.

[ii] See Chapter 8, section 8.6 "Decarbonize Buildings" and Appendix B for further discussion of legal authority.

Natural Climate Solutions

The RDF's Technical Report investigates the natural climate solutions (NCSs) available in the San Diego region and their potential to naturally sequester and store CO_2 and other GHGs. NCSs are processes that protect or enhance natural and working lands' (NWLs) ability to capture and store GHGs from the atmosphere through plants and soils or reduce emissions from NWLs. "Working lands" include agricultural lands like orchards, vineyards, pastures, nurseries, rangelands, croplands, etc. "Sequestration" is an annual measure of how many GHGs are removed from the atmosphere and "storage" is the total amount of GHGs that have been sequestered in plants and soils. Existing carbon stocks (Figure 12) are generally stable and can store carbon for decades if left undisturbed, so careful regional planning can minimize land use change that would emit this stored carbon. By understanding a landscape's carbon storage and sequestration potential, areas with high levels of stored carbon can be preserved as such and areas with high sequestration potential can be protected.

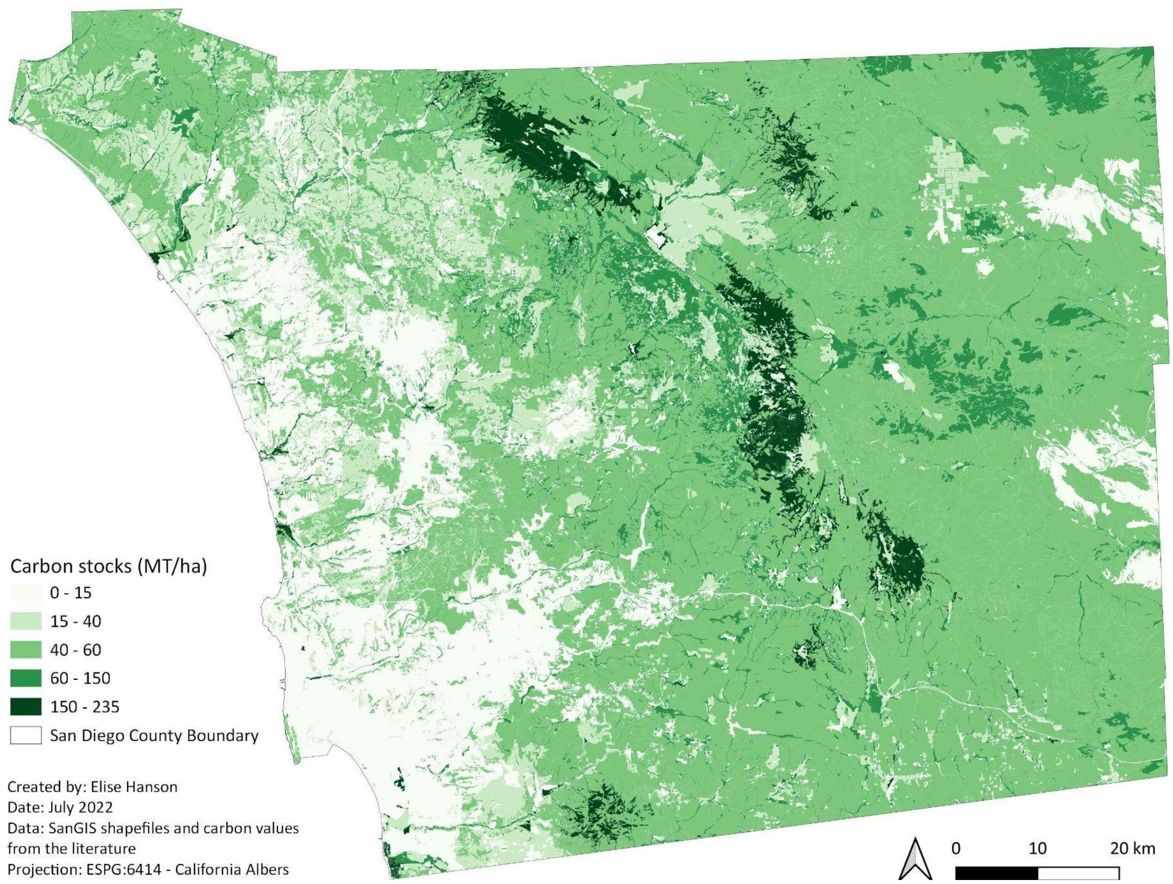

Figure 12 Total stored carbon (metric tons (MT) of CO_2 equivalent per hectare (ha)) estimates for the San Diego region. Darker colors represent larger carbon stock estimates and lighter colors represent lower stock estimates. Regionwide storage totals per vegetation category were calculated from these values and are in Table 5.2. Note that eelgrass beds were not included because they were not included in the SanGIS shapefiles. However, eelgrass beds are prevalent in both Mission and San Diego bays and are important blue carbon habitats.

Regional NWLs sequester and store large amounts of carbon dioxide, although not enough to account for human-caused emissions. NWLs can act as stronger *net* sinks than they currently do, though this will require investments in bolstering NCSs and minimizing carbon emissions from land and land use activities. To accurately account for net carbon land use emissions, local data need to be collected and integrated into regional carbon calculations. The region can expand annual carbon sequestration and long-term carbon storage through investing in NCSs that both increase natural sequestration and reduce emissions from the land, such as protecting NWLs; investing in "carbon farming;" restoring and expanding "blue carbon" habitats; planting trees and other plants in urban areas; preventing large-scale, destructive wildfires; and planting trees in NWLs or otherwise restoring them. Collecting and integrating local data into NCS policies, incentives, and management techniques can increase regional sequestration.

Avoiding land use changes by protecting natural and working lands represents the most effective and inexpensive NCS policy in the San Diego region, except where other decarbonization actions necessitate land use change (such as siting renewable energy infrastructure). Existing natural and working lands are natural carbon sinks, so preventing urbanization of these lands allows for continued annual sequestration and prevents one-time emissions from vegetation removal, soil disturbance, etc. This report estimates that natural annual sequestration in NWLs may be up 2 million metric tons (MMT) of CO_2 under ideal circumstances and that there may be 58 MMT of CO_2 stored in vegetation, woody debris, leaf litter, and soils, some of which would be released with land use change.

Housing development and renewable energy infrastructure siting are important activities and will require some land use change. Implementing these changes to minimize impacts on NWLs with large natural carbon stores, high sequestration potential, and/or high co-benefits (such as habitats that improve air and water quality, protect biodiversity, and support public health) will be critical.

Other important regional NCSs considered by the RDF's Technical Report may be less effective and/or more expensive for carbon sequestration, though they yield important co-benefits. These include carbon farming (farming practices that increase carbon sequestration and storage and minimize GHG emissions on agricultural lands), increasing wetland extent and quality (through protection, restoration, and expansion), and urban forestry and greening. Wildfire prevention will also be important for emissions and numerous other economic, ecological, and social reasons. Large-scale habitat restoration and reforestation, which were not considered in this report, are expensive and may not be effective. Other NCS options require significant capital investments and typically have smaller short-term sequestration returns than preservation.

NCSs offer quantifiable co-benefits beyond decarbonization. Each of the analyzed NCSs offer numerous quantifiable co-benefits. These co-benefits include, but are not limited to: improved air and water quality, improved public health outcomes, biodiversity protection, ecosystem functioning protection, reduced heat island effects through shading, improved aesthetics in urban areas, decreased water and fertilizer requirements on farms and rangelands, and the potential to increase environmental justice. These co-benefits should be considered when crafting and implementing policies to build ecological, economic, and social resilience.

All NCS decisions must center on equity considerations. NCSs should be viewed through both decarbonization and equity lenses. Whenever possible, urban greening, tree planting, climate farming, and habitat restoration projects should prioritize communities of concern because these NCSs have outsized co-benefits of improving air and water quality as well as human health. NCSs can help address historic inequities and environmental injustice.

The only quantified CAP measure relevant to this pathway is urban tree planting, but there are opportunities to implement additional NCSs in a collaborative way. Additional measures are possible under local land use authority. Tree planting measures contribute on average just over 1% of local GHG reductions in CAPs. Jurisdictional collaboration can enhance this. Additional NCS CAP measures are possible under existing authority and can contribute to land conservation, preservation, and restoration on natural and working lands. Private landowners and tribal governments can also preserve land, test and fund pilot projects for carbon removal and storage, and collaborate with public agencies. Collectively, there is an opportunity to expand protections for natural and working lands to fulfill the new California Senate Bill 27 (2021) mandate that calls for establishing NWL carbon removal and storage projects.

There are also opportunities to include local data in land management and planning and in CAPs. For instance, CAPs can utilize both publicly available data from agencies and universities and publicly available carbon accounting methodologies from agencies like the California Air Resource Board (CARB) to create stronger goals and measures. Additionally, the region can implement regular carbon accounting and track carbon stocks in NWLs over time to understand emission, preservation, and storage trends with land use decisions.

Legal authority to regulate negative emissions from NCSs and land use:[i] It remains unclear whether local jurisdictions' ability to use their authority over land use, zoning, land preservation, and agricultural easements extends to activities on private natural and working land beyond land use designation that would affect GHG emissions or sequestration. The region's land use jurisdiction is further complicated because it is composed of federal, State, tribal, and privately held land, submerged land, and waters. Various statutes and agencies

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[i] See Chapter 8, section 8.8 "Natural Climate Solutions" and Appendix B for further discussion of legal authority.

regulate different land types, with none focused on GHG emissions or sequestration as it relates to land use. State land use and regulating agencies also operate with a wide range of statutory mandates, which apply to lands under multiple jurisdictions and impact GHG emissions and accounting. California's statutes and executive orders require State land use agencies to account for GHG emissions from natural and working lands. Additionally, these State agencies are beginning to assess and regulate carbon removal and storage on these lands with significant targets in 2030. An opportunity exists for local jurisdictions to work with landowners and managers to achieve State, regional, and local goals related to NWLs.

Employment Impacts of Decarbonization for the San Diego Region

The RDF's Technical Report calculates the net change in energy sector jobs in response to the Central Case of the modeled decarbonization pathways from the EER model. Following California's Jobs and Climate Action Plan for 2030, the analysis focuses on employment changes from 2021-2030 to inform workforce development strategies. Additionally, this report analyzes overall average annual job creation from 2020-2050, based on the full timeline in the EER model. For phasing out fossil fuels and modeling associated job losses, the analysis focuses on the 2021-2030 period, where the Central Case of the EER model estimates modest reductions in fossil fuel-based activities. This primarily stems from the model's estimates of steady natural gas consumption and a 20% decrease in oil consumption by 2030 relative to current levels. The RDF's Technical Report focuses on quantitative employment impacts resulting from deep decarbonization efforts in the energy, building, and transportation sectors and informs a report by Inclusive Economics on workforce development strategies.[i]

Between 2021 – 2030, the Central Case decarbonization pathway would generate an average of nearly 27,000 direct, indirect, and induced jobs per year in the San Diego region. These new jobs will be created by expenditures on energy demand (Table 4) and supply (Table 5), which contribute roughly equally to total annual job creation.[ii] Note that significant labor opportunities in the fossil fuel sector continue through 2030.

[i] The Inclusive Economics report titled "Putting San Diego County on the High Road: Climate Workforce Recommendations for 2030 and 2050," is available at https://www.sandiegocounty.gov/content/dam/sdc/lueg/regional-decarb-frameworkfiles/Putting%20San%20Diego%20County%20on%20the%20High%20Road_June%202022.pdf.

[ii] For a more detailed accounting of these jobs, please refer to Chapter 6, section 6.3.

Table 4. Average number of jobs created in the San Diego region annually through energy demand expenditures from 2021-2030, by subsectors and technology. *Figures assume 1 percent average annual productivity growth.*

Investment Area	Average Annual Expenditure	Direct Jobs	Indirect Jobs	Direct Jobs + Indirect Jobs	Induced Jobs	Direct Jobs + Indirect Jobs + Induced Jobs
Vehicles	$7.7 billion	3,427	1,427	4,854	1,508	6,362
HVAC	$897.0 million	1,345	699	2,044	764	2,808
Refrigeration	$761.9 million	1,315	491	1,806	711	2,517
Appliances	$188.6 million	143	77	220	78	298
Construction	$113.4 million	263	149	412	146	558
Lighting	$106.6 million	177	95	272	100	372
Manufacturing	$45.7 million	40	32	72	27	99
Other commercial and residential	$38.9 million	59	30	89	33	122
Agriculture	$17.2 million	144	21	165	45	210
Mining	$2.4 million	1	1	2	1	3
TOTAL	$9.9 billion	6,914	3,022	9,936	3,413	13,349

Source: IMPLAN 3.1

Table 5. Average number of jobs created in the San Diego region annually through energy supply investment from 2021-2030, by subsectors and technology. *Figures assume 1 percent average annual productivity growth.*

Investment Area	Average Annual Expenditure	Direct Jobs	Indirect Jobs	Direct Jobs + Indirect Jobs	Induced Jobs	Direct Jobs + Indirect Jobs + Induced Jobs
Fossil fuels	$4.4 billion	2,538	3,777	6,315	3,805	10,120
Clean renewables	$629.5 million	1,488	601	2,089	848	2,937
Transmission and storage	$45.9 million	34	17	51	31	82
Additional supply technologies	$45.1 million	118	35	153	57	210
Other investments	$4.5 million	10	3	13	6	19
TOTAL	$5.1 billion	4,188	4,433	8,621	4,747	13,368

Source: IMPLAN 3.1

The RDF's Technical Report estimates that no jobs in the region's fossil fuel-based industries will be displaced before 2030, even with contractions in fossil fuel demand. The energy supply mix in the EER model suggests that there will be small to no changes in the consumption of fossil fuels before 2030 and few to no changes in the region's fossil fuel-related jobs before 2030 as a result.[i]

The County of San Diego and local governments should develop a viable set of just transition policies for the workers who will experience job displacement between 2031 – 2050. After 2030, the EER model's Central Case estimates large contractions in both oil and gas. The model predicts 95% contraction rates in oil and 75% in gas by 2050. Regional governments must begin developing policies for a just transition for these workers now so that they can gradually transition into jobs of equivalent or better quality in the clean energy economy or elsewhere.

A just transition will cost much less if it proceeds steadily rather than episodically. Under a steady transition, the proportion of workers who will retire voluntarily in any given year will be predictable, which will avoid the need to provide support for a much larger share of workers at any given time. The rate of the transition from fossil fuel to renewable energy-based jobs will impact the equity and fairness of the transition. Rapid changes and contractions would be more likely to result in sudden job losses, where steady changes and contractions would potentially result in fewer job losses as employees could transition to new jobs or could voluntarily retire.

Geothermal energy production from the five sites identified in Imperial County would generate 1,900 jobs per year over a 10-year period in Southern California. Chapter 2 identifies five areas for geothermal energy production in Imperial County. This chapter's analysis finds that there will be 1,900 jobs created per year in the Southern California region over a 10-year period for the development and operation of these five geothermal power plants, some of which may be in the San Diego region. These are in addition to the annual 27,000 jobs creation estimates in the chapter.

[i] Details on the EER model's Central Case, which was used here, can be found in Appendix A.

Local Policy Opportunity

The RDF's Technical Report assesses current CO_2 reduction commitments in CAPs to determine whether the region needs additional activity to set the region on a trajectory to meet decarbonization goals. Additionally, it identifies opportunities for local jurisdictions in the region to take further action to support the decarbonization pathways for energy production, transportation, buildings, and natural climate solutions.

Several novel analyses inform this chapter. First, it analyzes the authority of local governments and agencies to influence and regulate GHG emissions and summarizes the authority of key federal, State, and local agencies, and key legislation and regulation at the federal and State levels to clarify local governments' ability to act to reduce GHG emissions.[i] Second, it reviews all CAPs in the region to determine how frequently a given measure was included in CAPs, the relative GHG impacts of CAP commitments, and the integration of social equity considerations.[ii] Third, a scenario analysis estimates the total regional GHG reductions that would result from all adopted and pending CAP commitments. It then estimates the potential GHG impact of a scenario that applies the best CAP commitments to all jurisdictions.[iii] This scenario analysis takes the CAP commitment for a given CAP policy category – for example, tree planting goals – that will produce the single greatest relative GHG reductions and then applies that commitment to every jurisdiction in the San Diego region, regardless of current or planned commitments in that category. This may be considered the upper limit of potential GHG reductions from current CAP commitments. Finally, this chapter applies the results from these approaches and other analyses to identify opportunities for further local action and regional collaboration on each of the four decarbonization pathways.[iv]

Local jurisdictions have authority to influence and regulate GHG emissions. Local governments can influence and regulate GHG emissions by accelerating State statutory targets and policies, adopting ordinances to go beyond State law, and using unique authority to adopt and implement policies. Local authority comes from both constitutionally derived power, which grants a broad authority to promote public health, safety, or the general welfare of the

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[i] See Appendix B for more details.

[ii] See Chapter 8, section 8.3 for an overview and sections 8.5-8.8 for sector specific findings. These are also used to illustrate the gap between the deep decarbonization goals in Chapters 2 through 5 and the regional CAP commitments.

[iii] See section 8.4.

[iv] These opportunities were included in each relevant section for this Executive Summary, but they are included in the sector specific section in Chapter 8.

community, and delegated authority from State statutes. The full extent of a local jurisdiction's power to regulate GHG emissions is unknown.[i]

Adopted CAP commitments are insufficient to reach decarbonization goals. GHG reduction commitments in adopted CAPs for transportation, electricity, and buildings contribute a relatively small portion of the total reductions needed to reach net zero GHG emissions in 2045 (Figure 13, dashed line). Even if the most aggressive adopted CAP measures are applied to all jurisdictions in the region, significant emissions would remain, mostly from natural gas building end-uses and on-road transportation (Figure 13, dash-dot line). The chapter also analyzed the City of San Diego's pending 2022 CAP update, but even including these measures, significant emissions would remain.

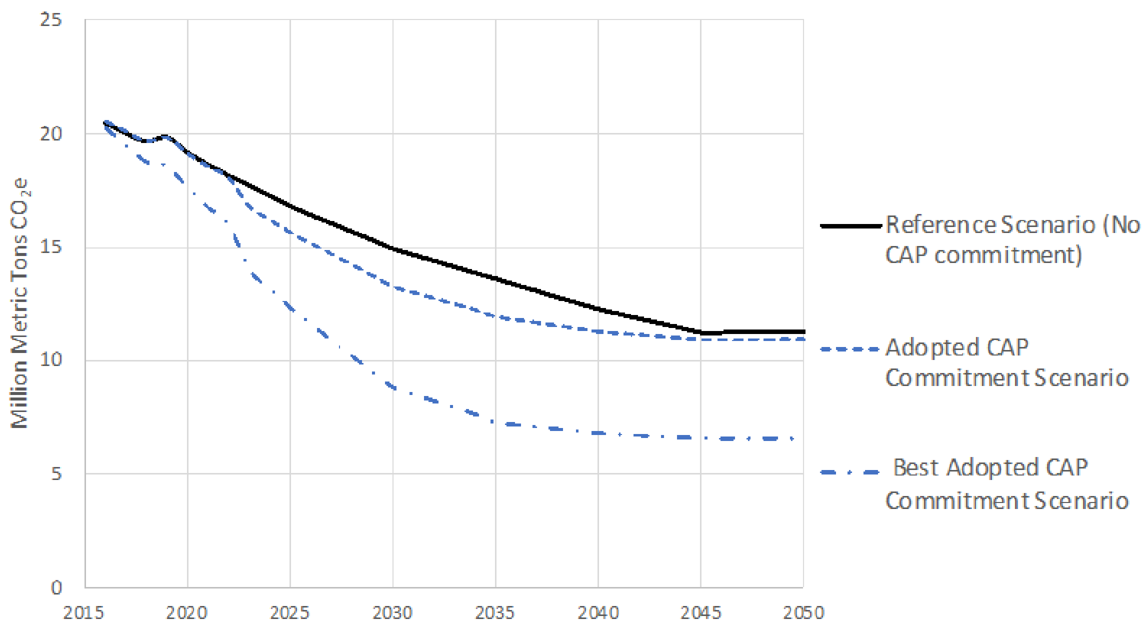

Figure 13. This graph shows the projected GHG emissions in the San Diego region from electricity generation, natural gas end-use in buildings, and on-road transportation in each of the scenarios analyzed. The Reference Scenario (solid line), where there are no CAP commitments, only shows reductions based on State and federal laws, mandates, actions, and goals. The Adopted CAP Commitments Scenario (dashed line) shows the remaining GHG emissions from a subset of total emissions if all current CAPs were applied in full as written. The Best Adopted CAP Commitment Scenario (dash-dot line) shows the remaining GHG emissions if the best adopted CAP commitment from each policy category is applied to every jurisdiction in the region, regardless of adopted CAP commitments. This graph shows that no analyzed scenario will allow the region to reach net zero emissions by 2050. Note that these analyses assume no new State and federal laws, mandates, actions, and goals, and that current ones do not change at any point in this period. Further, these analyses do not include all GHG emissions for the region.

[i] See section 8.2 and Appendix B for a more detailed discussion of authority.

Jurisdictions can adopt additional CAP measures and strengthen existing measures. Based on the review of CAPs, more jurisdictions can adopt stronger CAP measures, using other regional jurisdictions' measures as examples. Similarly, based on the scenario analysis of the combined GHG impacts of CAP measures, most jurisdictions can strengthen their existing CAP measures, especially in the transportation and building sectors. These sectors produce large GHG emissions (Figure 14, right), but on average represent disproportionately low emissions reductions in CAPs in 2035 (Figure 14, left).

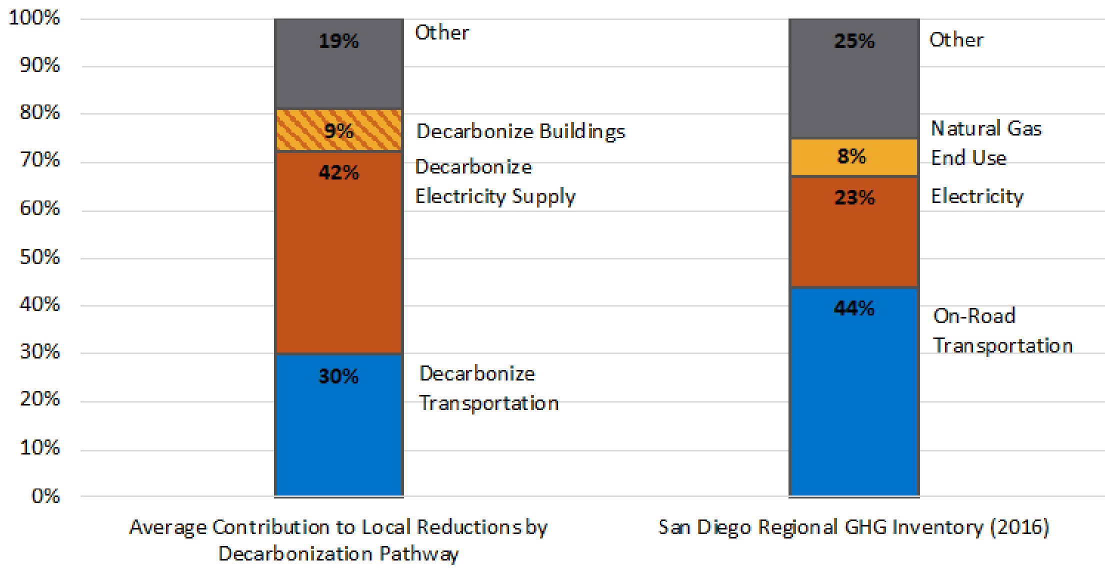

Figure 14. This graph shows the average contribution of each decarbonization pathway to total GHG reductions from adopted and pending local CAP measures in 2035 (left) and the distribution of 2016 regional emissions by emission source (right). It shows that emissions from transportation (blue, right side) account for nearly half of regional emissions, but on average corresponding reductions from CAP commitments only represent slightly more than a quarter of local GHG reductions in CAPs (blue, left side). Similarly, electricity accounts for about a quarter of regional emissions (dark orange, right side) but associated reductions contribute on average just under half of GHG reductions from CAP commitments (dark orange, left side). Note that because emissions associated with buildings come from both onsite natural gas combustion and electricity production, the building decarbonization portion of the bar is shaded to show both light and dark orange to correspond with both natural gas buildings (light orange) and the electricity supply (dark orange).

Integrating social equity into climate planning requires additional work. Based on a preliminary review, the integration of social equity in adopted and pending CAPs is limited, inconsistent, and lacks specificity. Additional work would be needed to develop the capacity and tools to understand and address the equity implications of all decarbonization policies in the San Diego region, including data collection and analysis; regional guidance documents; and regional working groups to coordinate, advise, track, and monitor how equity is being addressed in climate planning.

The San Diego Region as a Model

Although the San Diego region only accounts for 0.08% of global emissions, its regional decarbonization efforts can impact global emissions by generating followership among others and sharing durable, scalable, and replicable innovations. San Diego should actively highlight its efforts and communicate lessons learned in national and international fora. The creation of the San Diego RDF can serve as a case study for other jurisdictions across the U.S. and globally to learn from and adapt to their own long-term decarbonization planning endeavors. In addition to showcasing this effort in various national and international fora,[i] the United Nations Sustainable Development Solutions Network (SDSN) has produced a Guide that will serve as a toolkit for other communities, governing bodies, research groups, and sustainability practitioners to follow the process undertaken by the County of San Diego in their own decarbonization pursuits.

SDSN is working to share the RDF within three horizontal levels across its networks. SDSN will share the RDF and its key findings in national meetings and fora in the United States, international groups and consortiums, and the United Nations. For example, the project was presented during the Innovate4Cities Conference in October 2021 and the feedback and insights from this event will serve to inform the 2022 IPCC Sixth Assessment Report on impact, adaptation, and vulnerability to global climate change. These events provide an opportunity to showcase the results of this project and the San Diego region as a model for the world. With access to these audiences, the RDF can help inform global roadmaps and pathways to net zero.

The Guide for Regional Decarbonization will aid local jurisdictions in creating unique decarbonization frameworks. This Guide will provide background information as well as specific steps and advice on logistics, methodology, stakeholder engagement, long-term planning, and more. Although the resources within this Guide are relevant and applicable to decarbonization framework project teams beyond the US, frameworks being created in the context of emerging economies will likely use different approaches, perspectives, and strategies in climate action planning. This Guide will be free and available online at UC San Diego’s SDG Policy Initiative’s website (http://sdgpolicyinitiative.org/guide/) as a way to facilitate the creation of regional decarbonization frameworks and provide a practical roadmap for jurisdictions working toward net-zero goals.

[i] Chapter 9 and Appendix 9.A present extensive lists of US and global consortiums that San Diego County and other jurisdictions with decarbonization frameworks can connect with, attend, and join the networks to disseminate their findings across different scales.